Green supply chain management and financial performance: The mediating roles of operational and environmental performance

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Abstract
This study investigates the mediating effects of environmental and operational performance on the relationship between green supply chain management (GSCM) and financial performance. The proposed relationships are analysed using survey data from a sample of 126 automobile manufacturers in China. The results suggest that GSCM as an integral supply chain strategy is significantly and positively associated with both environmental and operational performance which then indirectly leads to improved financial performance. The results indicate the possible complementarity effects between various internal and external GSCM practices.
Keywords: Green supply chain management; Environmental performance; Operational performance; Financial performance; China

1. Introduction

Green supply chain management (GSCM) comprises of intra- and inter-firm management of the upstream and downstream supply chain through internal GSCM and external GSCM practices aiming at minimizing the overall environmental impact of both the forward and reverse flows (Klassen and Johnson, 2004; Narasimhan and Carter, 1998; Solér et al., 2010; Srivastava, 2007; Thun, 2010; Van Hoek, 1999; Yu et al., 2014; Zhu et al., 2008a). However, evidence shows that some GSCM practices do not lead to improved firm performance (Chavez et al., 2016; de Burgos-Jiménez et al., 2013; Eltayeb et al., 2011; Yang et al., 2011). Studies on the relationship between GSCM and firm performance have reached mixed, inconsistent, and even confusing conclusions (Chavez et al., 2016; Geng et al., 2017; Rao and Holt, 2005; Wong et al., 2017; Zhu et al., 2013). A recent meta-analysis by Golicic and Smith (2013) showed limited positive effects of GSCM on firms' financial outcomes, and those positive effects of GSCM on financial outcomes were smaller compared to the effects of GSCM on operational and market-based performance. This probably explains why many managers remain sceptical of the economic benefits of GSCM (Preuss, 2005).

It seems that the question "does it pay to be green?" (Hart and Ahuja, 1996) requires a revisit. Golicic and Smith (2013) suggest there might be indirect outcomes of GSCM through its effects on operational and market-based performance. Some researchers argue that environmental management creates profitability and market share through achieving efficiency or being lean (e.g., King and Lenox, 2001; Porter and van der Linde, 1995; Rothenberg et al., 2001). Other researchers argue that financial performance is improved by being environmentally friendlier (Klassen and McLaughlin, 1996). Growing evidence (Green et al., 2012; Lai and Wong, 2012; Vachon and Klassen, 2006; Zhu and Sarkis, 2004; Zhu et al., 2010a & 2013; Wong et al., 2017) showed that internal and external GSCM practices could affect economic or financial performance indirectly through ecological, operational and cost efficiencies. Yet, questions remain whether such mediation effects of operational and environmental performance apply to every internal and external GSCM practice.

One line of enquiry the literature has not explored is that the ways GSCM are being measured could have affected the observed mediating effects. The Delphi study by Seuring and Müller (2008a) revealed that the identification and measurement of the impact of GSCM remained a major issue. Zhu et al. (2013) found that some internal GSCM practices could have negative effects on economic performance, while there were positive effects of some external GSCM practices. Green et al. (2012) report similar findings. Such contradicting and yet crucial evidence leads to a new question: whilst it is possible to observe both positive and negative effects of different internal and external GSCM practices, could there be any synergetic effects when they are implemented together as an integral strategy? This intriguing question could be answered by a new perspective, that internal and external GSCM practices become an integral part of a supply chain strategy (Handfield et al., 2005), because only when implemented together, such practices help a firm create better profit and market share through the reduction of environmental risks and improvement of ecological efficiency of its supply chain (Porter and van der Linde, 1995; Van Hoek and Erasmus, 2000; Zhu et al., 2008a).

To examine the effects of an integral GSCM, there is a need for a GSCM construct that combines all internal and external GSCM practices, rather than separating internal and external GSCM practices into two different constructs, or examining each GSCM practice separately (see Zhu et al., 2013). Following this fresh perspective, this study addresses two research questions: (1) Do GSCM and all its components directly lead to performance improvement in financial performance; and (2) do environmental and operational performance mediate the relationship between GSCM and financial performance?

This study extends previous research by clarifying the effects of GSCM and its components on three key performance outcomes. By combining components of internal and external GSCM practices into one construct and examining the relationships and effects of each component, this study represents the first empirical work that explores the mediating impacts of environmental and operational performance from a new perspective. Clarification of whether the effect of a single versus integral GSCM set of practices on financial performance is direct or indirect through environmental and/or operational performance could bring some theoretical advancement. It not only helps clarify whether the inconsistent and ambiguous empirical findings of previous research (Eltayeb et al., 2011; Golicic and Smith, 2013; Yang et al., 2011) could be affected by the ways GSCM constructs are measured; furthermore, it could practically provide more precise managerial guidelines for firms to successfully achieve superior firm performance by adopting appropriate sets of GSCM practices.

2. Theoretical Model and Hypotheses

2.1. Green supply chain management (GSCM)

Academic and corporate interest in sustainable supply chain management has been growing over the last decade (Carter and Rogers, 2008; Harms et al., 2013; Pagell and Wu, 2009; Seuring and Müller, 2008b; Wittstruck and Teuteberg, 2012). Sustainable supply chain management refers to the management of the supply chain that considers the economic, environmental and social criteria to be fulfilled by all supply chain members (Hsu et al., 2016; Seuring and Müller, 2008b; Wittstruck and Teuteberg, 2012). This argument is compatible with the sustainability concept and triple bottom line (TBL) (Elkington, 1997), which provides the measures of business sustainability in terms of economic, social, and environmental dimensions (Carter and Rogers, 2008; Hsu et al., 2016; Seuring and Müller, 2008a). Thus, sustainable supply chains should encompass these dimensions across the whole supply chain (Pagell and Wu, 2009). However, considering these three dimensions simultaneously throughout the supply chain is a rather difficult task to achieve (Pagell and Wu, 2009). Despite the inherent complexity of the sustainability concept, from a supply chain perspective, it has been argued that the question for managers and researchers to answer should not be whether to become truly sustainable (across all TBL dimensions), but to use the TBL to measure progress towards being truly sustainable as the ultimate objective (Pagell and Wu, 2009).

As a sub-set of sustainable supply chain management, green supply chain management (GSCM) concerns internal environmental management practices within a company and external environmental management initiatives with an emphasis on cooperation across functions and with those of its customers and suppliers (Yu et al., 2014; Zhu and Sarkis, 2004; Zhu et al., 2008a). Environmental sustainability is improved by the application of appropriate management practices internally and concerted efforts with downstream consumers and upstream suppliers (Green et al., 2012; Rao and Holt, 2005; Vachon and Klassen, 2006; Wong et al., 2013). Supply chain partners' practices are integral to GSCM, through collaborative supply chains and efforts such as green purchasing embedded in supply interchanges between manufacturers, suppliers and customers, with cross-functional cooperation to obtain the maximum benefits over the long term whereby, ultimately, firms reap benefit from environmental management when the supply chain is acting in a cohesive manner, with cross-functional and cross-company processes geared toward sustainability (Rao and Holt, 2005; Van Hoek, 1999; Walton et al., 1998; Yu et al., 2014; Zhu and Sarkis, 2004). Thus, GSCM must be embedded across departmental boundaries within and between organizations, and environmental practices can only be achieved through cooperation and communication (Aspan, 2000; Zhu and Geng, 2001).

In this study, we conceptualize GSCM as a single unidimensional construct encompassing cross-functional cooperation for environmental improvements, and environmental collaboration with customers and suppliers (Vachon and Klassen, 2008; Zhu et al., 2010b). Most scholars have operationalized GSCM by dividing it into internal and external environmental management constructs, following the work of Zhu and Sarkis (2004) and Zhu et al. (2008a). This approach helps clarify the distinct effects of internal and external environmental management, but ignores the facts that internal and external environmental management practices are closely related. A single GSCM construct is required because all GSCM practices should complement each other and therefore be an integral part of a firm's environmental management initiative. Past research has shown that environmental management systems, as a major part of internal environmental management, complement efforts to cooperate with external supply chain partners (Darnall et al., 2008). Environmental information can be perceived and used in different ways, thus a concerted set of GSCM practices is necessary (Solér et al., 2010). Moreover, uncertainty in a supply chain related to environmental management issues can only be reduced by building trust along the entire supply chain (Sharfman et al., 2009).

2.2. GSCM, environmental and operational performance

Performance improvement is a main driver for firms that seek to adopt GSCM practices (Zhu et al., 2008b, 2010a). The assumption is that implementing environmental management practices will lead to improved firm performance (Dechant and Altman, 1994). Attention to the relationship between GSCM practices and performance has become increasingly widespread in both academic theory and corporate practice. It has been argued that success in addressing environmental issues may increase competitiveness and provide new ways to add value to core business programmes (Hansmann and Kroger, 2001). Several empirical studies have investigated the impact of GSCM on firm performance (e.g., Green et al., 2012; Lai and Wong, 2012; Rao and Holt, 2005; Yu et al., 2014; Zailani et al., 2012; Zhu and Sarkis, 2004, 2007), but, as noted earlier, empirical evidence on the relationship between GSCM and performance improvement remains mixed, inconsistent and confusing (Linton et al., 2007; Markley and Davis, 2007; Yu et al., 2014; Zhu et al., 2010b).

GSCM practices are increasingly being recognized as systematic and comprehensive mechanisms to achieve superior environmental and operational performance (Green et al., 2012; Lai and Wong, 2012; Zailani et al., 2012; Zhu and Sarkis, 2004; Zhu et al., 2008a, 2008b, 2010b). GSCM reduces environmental damage because collaboration across functions, suppliers and customers helps identify and confront environmental issues shared by the supply chain (Wong et al., 2015). By working together, the supply chain can reduce waste and emissions in production and transportation processes, as well as products in use through implementation of eco-design and eco-packaging. The positive relationship between some aspects of GSCM and environmental performance was initially pointed out by Zhu and Sarkis (2004). Zailani et al. (2012) also found that the implementation of sustainable packaging had a significant positive effect on environmental performance. Green et al. (2012) found that, generally, GSCM led to improved environmental performance, especially due to environmental cooperation with customers. GSCM in this study is a more comprehensive set of practices. We therefore posit:

H1: GSCM is positively related to environmental performance.

Previous research has argued that GSCM can improve operational performance in terms of cost, quality, flexibility and delivery (e.g., Green et al., 2012; Klassen and Whybark, 1999; Vachon and Klassen, 2008; Yu et al., 2014; Zailani et al., 2012). GSCM can be used as an opportunity to review the design of the product and production processes. Proactive environmental management emphasizes the use of pollution-prevention instead of pollution-control technologies in production processes (Klassen and Whybark, 1999). Pollution-prevention technologies are more efficient in the long-term because they tend to consume less energy and raw materials, leading to lower operating costs. Moreover, they produce virtually no pollution meaning no cost of pollution control is required. Greener products are often perceived as better quality. The use of pollution-prevention technologies means there is less need to manage waste and process quality issues, leading to a better ability to respond to changes in the market (Klassen and McLaughlin, 1996).

There is currently some evidence of a positive relationship between some aspects of GSCM and operational performance. Lai and Wong (2012) identified that implementing green logistics management can improve manufacturers' operational performance. Vachon and Klassen (2008) found that collaboration with suppliers on environmental issues was linked to improvement in three traditional dimensions of manufacturing performance, namely quality, delivery and flexibility. They also found that environmental collaboration with customers was significantly and positively associated with greater quality improvement. Zailani et al. (2012) showed that the adoption of GSCM practices such as environmental purchasing led to improved operational performance. However, GSCM in this study is a more comprehensive set of practices. Our theoretical argument regarding its effect on operational performance remains unexamined. We therefore argue the need for testing the following hypothesis:

H2: GSCM is positively related to operational performance.

2.3. Environmental, operational and financial performance

Following previous studies (e.g., Flynn et al., 2010), our study uses measures such as growth in sales, growth in profit, and growth in market share to represent the financial performance of firms. Previous research (e.g., Green et al., 2012) suggests that improvement in the overall financial performance of a firm is originated from the investment in operational resource efficiency and marketing of environmental benefits. In this study, environmental performance means a decrease in the levels of environmental pollutants, such as reduction of air, water and solid wastes, a decrease in consumption for hazardous/harmful/toxic materials, and a decrease in frequency for environmental accidents (Zhu and Sarkis, 2004; Zhu et al., 2010b). Better environmental performance provides legitimacy for firms to operate and even better profit margins through setting new industry standards (Hart, 1995). When it is hard for competitors to imitate such high standards, firms may gain more market shares by offering environmentally friendlier products produced by environmentally friendly production processes.

Better financial performance can also be achieved through cost and resource efficiency. As argued, better environmental performance can be achieved by implementing pollution-prevention technologies, leading to zero waste meaning no cost is spent on pollution control and high cost due to waste disposal which means less cost for addressing environmental spillage and liability (Klassen and McLaughlin, 1996); less cost is also spent on energy consumption and raw materials or treatments of waste owing to the use of hazardous materials. With the prospect of increasing profit margin and market share at an overall lower cost through achieving better environmental performance, we posit:

H3: Environmental performance is positively related to financial performance.

Better operational performance reflects the ability to satisfy customers in terms of on time and fast delivery of high quality products and services, operations flexibility, and waste elimination in production processes (Flynn et al., 2010; Green et al., 2012; Lai and Wong, 2012; Wong et al., 2011). As with environmental performance, operational excellence generates cost savings while also satisfying changing customer demands for environmentally sustainable products and services which, in turn, lead to improved financial performance (Green et al., 2012). Quality, flexibility and delivery reliability are the basis for customer satisfaction, leading to long-term customer loyalty and financial gains.

H4: Operational performance is positively related to financial performance.

2.4. The mediating effects of environmental and operational performance

Previous studies (e.g., Green et al., 2012; King and Lenox, 2002; Sueyoshi and Goto, 2010; Yang et al., 2011) have provided some initial empirical support for the positive relationship between environmental and operational performance and financial performance. Using data envelopment analysis, Sueyoshi and Goto (2010), examining the relationships among environmental, operational, and financial performance measures in the Japanese manufacturing industry, found that large Japanese manufacturing firms had technology and capital to enhance their environmental and operational performance, and that the improvement in the two efficiency measures led to improved financial performance. By examining the impact of GSCM practices on performance improvement, Green et al. (2012) found that operational performance positively affected financial performance. Hart and Ahuja (1996), King and Lenox (2002) and Yang et al. (2011) found that environmental performance was significantly related to improved financial performance.

The above existing studies were carried out under different contexts and countries. They applied different measures for environmental, operational and financial performance, and they did not specifically verify the mediating roles of operational and environmental performance. Here, we argue GSCM practices are not dedicated to generating profits and market share; they are implemented for achieving cost and resource efficiencies while reducing environmental damages as stipulated in hypotheses H1 and H2. It is the better environmental performance (H3) and operational performance (H4) that generates new revenue, profitability and cost reduction. In other words, the effect of GSCM on financial performance is indirect, through creating better operational and environmental performance. Therefore, we argue the need for testing the following hypothesis:

H5: The effect of GSCM on financial performance is fully mediated by operational and environmental performance.

Given the set of hypotheses (H1-H5), our overall expectation is that environmental and operational performance act as mediators of the relationship between GSCM and financial performance. With mediating effects, there is a significant intervening mechanism (i.e., environmental and operational performance) between an antecedent variable (GSCM) and the consequent variable (i.e., financial performance). Our conceptual framework (see Figure 1) shows that the absence of a significant GSCM-financial performance path (i.e., H5) would suggest that environmental and operational performance fully mediate the relationship.

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3. Methodology

3.1. Sample and data collection

The data for this study were obtained from a questionnaire survey of automotive manufacturers in China. A random sample of 1,000 manufacturing plants was drawn from the Directory of China's Automotive Industry Manufacturers, which was jointly edited by the Wheelon Autoinfo, China Association of Automobile Manufacturers (CAAM), and Society of Automotive Engineers of China (SAEC). Our survey respondents comprise firms in several provinces throughout China, e.g., Chongqing and Sichuan, Shanghai and Jiangsu, Hubei, and Guangdong, where most of the large automobile manufacturing bases in China are located. For each randomly selected automotive manufacturer, we identified a key informant by telephone and email to obtain their preliminary agreement to participate (Dillman, 2000). The questionnaires were then sent via email or post to 600 informants who agreed to take part in our study. Our respondents were typically in positions such as general manager, director, supply chain manager, operations manager, and sales and marketing managers. Most of our respondents were corporate managers with an average of more than eight years of work experience in their company; thus, it is reasonable to expect that the respondents had sufficient knowledge to complete the survey, ensuring the quality of the collected data.

Following previous studies on survey research (e.g., Dillman, 2000; Frohlich, 2002; Zhao et al., 2006), several steps were employed to maximize the response rate and minimize response bias in subjective data obtained from the respondents. First, since the measurement scales adapted from the literature were in English, the original scales were first developed in English and then translated into Chinese, to ensure the reliability of the questionnaire (Zhao et al., 2011). Several questions were reworded to improve the accuracy of the translation and to make it relevant to environmental management practices in China. Second, we carried out a pilot-test with both academics and practitioners, sending the questionnaire survey to academics from the field of operations and supply chain management to review and provide feedback. We then conducted a pilot-test with six supply chain and production managers at automakers in China using in-depth face-to-face interviews (O'Leary-Kelly and Vokurka, 1998). Based on the feedback from academics and industry experts, we modified the wording of some questions when there was any confusion. Third, follow-up calls were carried out to encourage completion and return of the questionnaires and to clarify any questions that had potentially arisen (Frohlich, 2002; Zhao et al., 2006). After several telephone and email reminders, we received 126 completed questionnaires, a response rate of 21%. Table 1 presents a profile of the respondents.

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3.2. Non-response bias and common method bias

To examine the possible non-response bias and the generalizability of findings to the population (Miller and Smith, 1983), we conducted a t-test to check whether there is any significant difference on demographic characteristics of annual sales and number of employees between early and late responses (Armstrong and Overton, 1977). Here, we assume the non-respondents shared the same characteristics as the late respondents. The t-test results indicate no significant statistical differences ($p < 0.05$), which suggests that the questionnaires received from respondents represent an unbiased sample.

As the survey data were gathered from single respondents, the potential for common method bias was assessed, as recommended by Podsakoff et al. (2003). First, Harmon's one-factor test using exploratory factor analysis (EFA) was conducted, which revealed several distinct factors, the first of which explained 39.326% of the variance, which is not much of the total. Second, confirmatory factor analysis (CFA) was applied to Harman's single-factor model (Flynn et al., 2010; Podsakoff et al., 2003). The model fit indices (χ^2/df (730.480/209) = 3.495, CFI = 0.640, IFI = 0.646, TLI = 0.602, RMSEA = 0.141, SRMR = 0.112) were unacceptable and were significantly worse than those of the measurement model. The results indicate that a single factor model is not acceptable, thus common method bias is not an issue in this study.

3.3. Measures

Table 2 illustrates the measures used in this study. The GSCM scale was adapted from Vachon and Klassen (2008) and Zhu et al. (2010b), which included cross-functional cooperation for environmental improvements, building environmental collaboration with upstream suppliers and downstream customers, and sending environmental requirement to suppliers. A five-point scale (where 1 = no plan to implement and 5 = full implementation) was also used for GSCM. We defined benefits gained through GSCM as improvements in environmental performance (Zhu et al., 2010b), operational performance (Flynn et al., 2010; Lai and Wong, 2012; Wong et al., 2011), and financial performance (Flynn et al., 2010). Respondents were asked to assess their performance relative to the main competitors over the last three years. The performance indicators were measured using a five-point Likert scale (ranging from 1 “much worse than competitors” to 5 “much better than competitors”), whereby higher values indicated better performance. In addition, we included firm size as a control variable in our model because larger firms may have more resources to implement GSCM practices for performance improvement. Firm size was measured by number of employees.

4. Data Analysis and Results

A two-step approach (measurement model and structural model) and structural equation modelling (SEM) were used to test the conceptual model (Anderson and Gerbing, 1988).

4.1. Measurement model

The unidimensionality of the key theoretical constructs was assessed using CFA. As summarized in Table 2, unidimensionality is confirmed because all fit indexes including the comparative fit index (CFI), incremental fit index (IFI) and Tucker-Lewis index (TLI) were above 0.9 and RMSEA and SRMR were below 0.08 (Byrne, 2009; Hair et al., 2006; Hu and Bentler, 1999). The Cronbach’s alpha and critical ratio (CR) of the constructs exceeded the widely-recognized rule of thumb of 0.70 (Fornell and Larcker, 1981; Nunnally, 1978; O’Leary-Kelly and Vokurka, 1998), thus the theoretical constructs exhibit adequate reliability.

Convergent validity was evaluated by conducting CFA (O’Leary-Kelly and Vokurka, 1998). As shown in Table 2, all indicators in their respective constructs had statistically significant factor loadings greater than 0.50, and the t-values were all larger than 2, which demonstrates the convergent validity of the theoretical constructs (Anderson and Gerbing, 1988; Flynn et al., 2010; Hair et al., 2006; Zhao et al., 2011). While the average variance extracted (AVE) values for some constructs were marginally less than the cut-off point of 0.50 suggested by Fornell and Larcker (1981), we satisfied the more stringent criteria set by several other studies, as indicated above. Some empirical studies have used AVE values below 0.50 to establish convergent validity (e.g., Flynn et al., 2010; Sarkis et al., 2010; Zhao et al., 2011). Based on these results, we conclude that the constructs and scales have convergent validity.

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Discriminant validity was examined by comparing the correlation between the construct and the square root of AVE. Discriminant validity is indicated if the AVE for each multi-item construct is greater than the shared variance between constructs (Fornell and Larcker, 1981). The square root of AVE of all the constructs was greater than the correlation between any individual pair, as shown in Table 3, which evinces discriminant validity (Fornell and Larcker, 1981).

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4.2. Structural model

We assessed the proposed relationships and mediation (see Figure 1) through testing two models using SEM (Baron and Kenny, 1986; Hair et al., 2006). The results are summarized in Table 4, which shows that both models had acceptable fit indices above 0.90 (Byrne, 2009; Hair et al., 2006; Hu and Bentler, 1999). Model 1, which includes only the direct path of GSCM-financial performance was tested; the analysis indicates that GSCM was significantly and positively related to financial performance ($\beta = 0.501$, $p < 0.001$).

Model 2 includes both the direct path of GSCM-financial performance and the indirect paths through mediators (i.e., environmental and operational performance). The results for Model 2 in Table 4 show that GSCM was significantly and positively related to environmental ($\beta = 0.538$, $p < 0.001$) and operational performance ($\beta = 0.642$, $p < 0.001$). Thus, H1 and H2 were supported. Model 2 also shows that there were statistically significant positive relationships between environmental performance and financial performance ($\beta = 0.218$, $p < 0.05$) and between operational performance and financial performance ($\beta = 0.675$, $p < 0.001$). Thus, H3 and H4 were supported.

As depicted in Table 4, the analysis reveals that the significant effect of GSCM on financial performance under Model 1 ($\beta = 0.501$, $p < 0.001$) became insignificant ($\beta = -0.024$, n.s.) when two mediators (i.e., environmental and operational performance) were added in Model 2. Hence, H5 was accepted. The full set of results suggests that GSCM indirectly influenced financial performance through environmental and operational performance.

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4.3. Post-hoc analysis

We further conducted some post-hoc analysis to compare the effects of GSCM practices at a component (GSCM1 to GSCM7) and construct level. First, we regressed each of the three performance outcomes against firm size as a control variable and GSCM as an integral construct (results in Table 5a), and then GSCM practices at a component level (results in Table 5b). The results showed that GSCM as a construct (an integral set of practices) was positively associated with the three performance outcomes with coefficients ranging from 0.417 to 0.532 at $p < 0.001$ (Table 5a). These results are like the SEM results (Table 4).

However, only some of its components had positive associations with the performance (Table 5b). Specifically, only GSCM4 (cooperation with customers for eco-design) had a positive relationship with environmental performance at $p < 0.01$ while GSCM5 (developing a mutual understanding of responsibilities regarding environmental performance with customers) and GSCM7 (making joint decisions with customers about ways to reduce overall environmental impact of our products) were positively related to financial performance at $p < 0.05$. In fact, GSCM5 was only marginally related to operational performance at $p < 0.10$. Interestingly, also observed by Zhu et al. (2013), there were some negative coefficients, even though they were not significant.

------------------------------ Insert Table 5a ------------------------------

------------------------------ Insert Table 5b ------------------------------

The above contrasting results between Table 4 and Tables 5a and 5b suggest the possible synergetic effects among components of GSCM practices (GSCM1-7) when they acted together as an integral GSCM strategy. We therefore checked the correlations among all the GSCM components, and found that they were all positively correlated, as shown in Table 6. This suggests the significant path coefficients in the SEM models (Model 1 and 2) must have been generated by some forms of complementarity among the seven GSCM components.

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5. Discussion and Implications

5.1. Theoretical implications

Although there are studies about GSCM and its performance effects among manufacturers in China (Yu et al., 2014; Zhu and Sarkis, 2004; Zhu et al., 2008c; 2010a; 2013), USA (Green et al., 2012), Thailand (Wong et al., 2017) and elsewhere, there remains a lack of concrete understanding and evidence concerning the direct and indirect effects of GSCM on financial performance (Golicic and Smith, 2013). While some scholars have previously pointed out the possibility of mediation effects (Green et al., 2012; King and Lenox, 2002; Sueyoshi and Goto, 2010; Yang et al., 2011), empirical evidence based on studies that separated internal from external GSCM practices (e.g., Green et al., 2012; Wong et al., 2017; Zhu et al., 2013) seem to suggest some GSCM practices could have positive, negative and insignificant relationships with operational, environmental and financial performance. One explanation for the lack of effects on financial performance among the Chinese auto industry (Zhu et al., 2008b) is that the adoption of GSCM remained immature but the more recent evidence from USA and Thailand (Green et al., 2012; Wong et al., 2017) casts doubt to this conjecture.

This study clarifies that the indirect effect of GSCM on financial performance could be mediated by operational and environmental performance when internal and external GSCM practices are implemented as an integral strategy. The study provides some of the first evidence that only some GSCM practices lead to improved environmental, operational performance, and financial performance; however, when seven internal and external GSCM practices are implemented as an integral strategy, GSCM could indirectly affect financial performance through both environmental and operational performance. Our findings on the indirect effects of GSCM on financial performance, based on Chinese auto manufacturers, provide a more holistic understanding compared to past studies that examined only specific types of internal and external GSCM practices (e.g., Green et al., 2012; Lai and Wong, 2012; Vachon and Klassen, 2008; Yu et al., 2014; Zhu and Sarkis, 2004). Particularly, past findings that external GSCM practices had little effect on internal performance (Eltayeb et al., 2011) provides some understanding but our findings suggest internal and external GSCM practices together could improve internal efficiency. It is shown that internal environmental practices could lead to poor market-based and financial performance (Yang et al., 2011), but the theoretical insights this study adds is that an integral approach to internal and external GSCM strategy could possibly mitigate such negative effects.

Our findings are important for theoretical advancement in the field of GSCM because the effects of GSCM among Chinese auto manufacturers in this study might be different from past studies. This study provides more recent data and a theoretical model dedicated to test the mediating effects of operational and environmental performance, which are a timely situation in China. Resource scarcity, environmental degradation and increasing pressures from various stakeholders (such as industrial associations and international customers) have caused the Chinese governments (both local and national) to exert pressure through increasing environmental regulatory and taxation policies. China suffers from a severe pollution problem, particularly air pollution in urban areas, in large part due to cars (BBC, 2011). The Chinese government is attempting to boost the green auto industry to be more sustainable and competitive, focusing on electric and hybrid cars and battery production (BBC, 2011; Yap, 2012). To respond to stakeholder pressures, it is important for automakers in China to implement GSCM practices. As expected by our theoretical argument, the implementation of a set of comprehensive GSCM initiatives (including cross-functional cooperation for environmental improvements and making joint decisions with customers and suppliers concerning how to reduce overall environmental impact) had enabled auto manufacturers to achieve superior environmental and operational performance which, in turn, leads to improved financial performance.

This study extends previous environmental management and GSCM research by clarifying the potential causal linkages among the environmental, operational and financial benefits from the implementation of GSCM initiatives. Our findings go beyond corroborating with prior empirical studies that suggest both environmental and operational performance are significantly and positively associated with financial performance, (e.g., Green et al., 2012; Hart and Ahuja, 1996; Klassen and McLaughlin, 1996; King and Lenox, 2002; Yang et al., 2011). Knowing that better environmental and operational performance could improve financial performance, this study explains an integral approach to GSCM indirectly affects financial performance through generating environmental and operational efficiency. This is a particularly important finding because most previous studies on GSCM (e.g., Lai and Wong, 2012; Zailani et al., 2012; Zhu and Sarkis, 2004) have not clearly clarified the linkages among environmental, operational and financial performance. The comparison of our research findings with those of previous studies

(Wong et al., 2017; Zhu et al., 2013) indicates that better understanding of the effects of GSCM on performance can be achieved by distinguishing the effects of indivual GSCM practices from those with a set of complementing GSCM practices. Based on our empirical results, we show that the relationship between GSCM and financial performance can be more precisely explained when the linkages among different measures for environmental and operational performance are included as mediators. Studies which consider only one or two performance measures (environmental, operational or financial) or ignore the linkage among the different performance measures may generate confusing results or draw erroneous conclusions.

5.2. Implications for managers and policy makers

Our findings provide valuable guidelines for managers. Our study indicates that managers need to develop an integrated green supply chain strategy. To achieve potential competitive advantages through green supply chains, it is important for firms to implement different environmental management practices that focus not only on internal green operations but also environmental collaboration with upstream suppliers and downstream customers across the entire supply chain. Significant insight from our research is that managers should commit to a programme of comprehensive collaboration across functional departments, suppliers and customers to implement GSCM practices, instead of implementing an environmental management standard symbolically (Boiral, 2007), or simply implement one or two GSCM practices. Managers need to understand it is the complementarity effects between different internal and external GSCM practices that generate improved environmental and operational performance, and it is better environmental and operational performance that provides the ecological and cost efficiency required to improve financial performance. These insights give managers a new way to understand the implementation of GSCM practices and their pathways to achieving superior performance outcomes.

Another implication is that managers should not expect GSCM to directly influence financial performance. Our findings caution that GSCM affects financial performance indirectly through both environmental and operational performance which means when justifying a business case for implementing GSCM practices, managers should focus on identifying the set of integral GSCM practices that could improve environmental and operational performance, instead of using financial gain such as payoff as the usual criterion for making strategic decisions. Too much expectation on financial performance could lead to a failure to focus on creating resource efficiency.

Our results also yield several implications for policy makers. The findings of the significant positive effects of GSCM on firm performance in China's manufacturing industry provide policy makers with a comprehensive understanding of the benefits and costs associated with the implementation of GSCM practices. In China, environmental protection has become an increasingly pressing issue. Government policy makers could make more effort to enlighten manufacturers on the implementation of GSCM practices. Policy makers should take a proactive role in developing relevant environmental regulations to encourage manufacturing firms to develop green supply chains as a comprehensive and integral strategy so that Chinese companies are more successful in implementing GSCM practices with proper guidelines and regulations (Geng et al., 2017). It would be fruitful for policy makers from China and other similar economies to formulate guidelines for environmental management, following our recommendation for an integral approach, to support the implementation of the set of GSCM practices that are more likely to deliver long-term sustainable performance and success.

6. Conclusions

This study makes important contributions to the GSCM literature by developing and testing a conceptual model examining the mediating role of environmental and operational performance in the relationship between GSCM and financial performance. The ambiguous conclusions of previous studies warrant investigation of the relationships between GSCM and performance outcomes. Our findings of the mediating role of environmental and operational performance help clarify the mixed empirical findings concerning the effect of an integral approach to GSCM on firm performance. We show that the argument that GSCM directly creates financial performance is unfounded because GSCM focuses on creating resource and operational efficiency that might eventually influence profitability and market share. A firm's financial performance depends upon many factors in addition to resource efficiency. From a practical perspective, our findings provide managers with a deeper understanding of how to achieve superior financial performance through implementing GSCM practices.

Some limitations of this study may warrant further consideration in future research. First, in this study, we conceptualized GSCM as a single unidimensional construct. Previous research (e.g., Wong et al., 2017; Yu et al., 2014; Zhu and Sarkis, 2004; Zhu et al., 2013) conceptualizing GSCM as a multidimensional construct, including internal environmental management and external environmental cooperation with customers and suppliers, has produced findings different from ours. Future research could compare the effects of both unidimensional and multidimensional GSCM constructs on different performance measures. Second, there are some factors that may influence GSCM and its effect on performance improvement, such as environmental regulatory pressure, customer and supplier pressure, and economic pressure (Lai and Wong, 2012). Future research may investigate how these factors affect the implementation of GSCM practices and firm performance (e.g., in terms of mediation and/or moderation testing). Third, it is hoped that our empirical results and theoretical and managerial implications are useful for not only China's automotive manufacturing industry but also manufacturing firms in other industries (textiles and apparel or chemicals and petrochemicals) and countries (e.g., Japan or Germany). However, omitting other industries and countries may bias the sample and limit generalizability of the results (Sarkis et al., 2010; Sueyoshi and Goto, 2010; Wong et al., 2011). Thus, future research should test the applicability and confirm the results obtained in our study in different cultural settings. Fourth, given that GSCM and sustainability has only been significantly operationalized in industry since the 2000s, it would be useful to examine the impact on performance over the long term (e.g., comparing performance dimensions before and after implementation over the course of many years or even decades). This is particularly relevant to the financial performance of GSCM itself, as high initial investment in green initiatives and operations often requires a long repayment period.

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Table 1: Demographic characteristics of respondents

	Number of firms	Percentage of samples (%)
Automotive industry		
Automaker	38	30.2
First-tier supplier	68	54.0
Second-tier supplier	12	9.5
Others	8	6.3
Total	126	100.0
Annual sales (in million Yuan)		
Below 10	2	1.6
10-50	12	9.5
50-100	16	12.7
100-500	32	25.4
500-1,000	14	11.1
More than 1,000	50	39.7
Number of employees		
1-99	5	4.0
100-199	16	12.7
200-499	32	25.4
500-999	13	10.3
1,000-4,999	33	26.2
5,000 or more	27	21.4

Table 2: CFA results: construct reliability and validity analysis

Construct	Factor loadings (*t*-values)	Reliability and validity
1. Green supply chain management		α = 0.851; CR = 0.856; AVE = 0.465
Cross-functional cooperation for environmental improvements	0.594 (–)	
Require suppliers to use environmental packaging (degradable and non-hazardous)	0.560 (5.199)	
Making joint decisions with supplies about ways to reduce overall environmental impact of our products	0.626 (5.656)	
Cooperation with customers for eco-design	0.585 (5.373)	
Developing a mutual understanding of responsibilities regarding environmental performance with customers	0.765 (6.489)	
Working together with customers to reduce environmental impact of our activities	0.800 (6.669)	
Making joint decisions with customers about ways to reduce overall environmental impact of our products	0.793 (6.637)	
2. Environmental performance		α = 0.899; CR = 0.901; AVE = 0.646
Reduction of waste water	0.745 (–)	
Reduction of solid wastes	0.854 (9.593)	
Decrease in consumption for hazardous/harmful/toxic materials	0.809 (9.066)	
Decrease in frequency for environmental accidents	0.808 (9.049)	
Improve a company's environmental situation	0.799 (8.941)	
3. Operational performance		α = 0.828; CR = 0.838; AVE = 0.468
Quickly respond to changes in market demand	0.598 (–)	
The capability to make rapid product mix changes	0.682 (6.044)	
An outstanding on-time delivery record to our customer	0.815 (6.788)	
The lead time for fulfilling customers' orders is short	0.755 (6.475)	
Provide a high level of customer service	0.698 (6.142)	
Reduce waste in production processes	0.514 (4.877)	
4. Financial performance		α = 0.901; CR = 0.903; AVE = 0.700
Growth in sales	0.916 (–)	
Growth in return on sales	0.779 (11.321)	
Growth in profit	0.835 (12.884)	
Growth in market share	0.810 (12.141)	
Model fit statistics: χ^2/df (265.601/203) = 1.308; RMSEA = 0.050; CFI = 0.957; IFI = 0.958; TLI = 0.951; SRMR = 0.059		

Table 3: Descriptive statistics

	Mean	S.D.	1	2	3	4
1. Green supply chain management	3.833	0.634	0.682[a]			
2. Environmental performance	3.660	0.699	0.468**	0.804		
3. Operational performance	4.013	0.605	0.521**	0.497**	0.684	
4. Financial performance	3.427	0.867	0.410**	0.476**	0.675**	0.837

Note: [a] Square root of AVE is on the diagonal.
*** $p < 0.01$. (2-tailed).*

Table 4: Results of mediation test using SEM

	Model 1 β (*t*-value)	**Model 2** β (*t*-value)
Structural paths		
GSCM → environmental performance (H1)		0.538 (4.524)***
GSCM → operational performance (H2)		0.642 (4.573)***
GSCM → financial performance (H4)	0.501 (4.565)***	-0.024 (-0.196)
Environmental performance → financial performance (H3)		0.218 (2.392)*
Operational performance → financial performance (H4)		0.675 (4.633)***
Control variables		
Firm size → Environmental performance		0.019 (0.232)
Firm size → Operational performance		-0.290 (-3.403)***
Firm size → Financial performance	-0.177 (-2.139)*	0.009 (0.118)
Model fit statistics		
χ^2	61.851	289.455
df	52	222
χ^2/df	1.189	1.304
RMSEA	0.039	0.049
CFI	0.985	0.954
IFI	0.985	0.955
TLI	0.981	0.947
SRMR	0.045	0.073

*Notes: *** $p < 0.001$; * $p < 0.05$.*

Table 5a: Effect of GSCM on performance: regression results

	Environmental performance		Operational performance		Financial performance	
	Step 1	**Step 2**	**Step 1**	**Step 2**	**Step 1**	**Step 2**
Control variable						
Firm size	0.044 (0.486[a], 1.000[b])	0.023 (0.284, 1.002)	-0.220 (-2.507, 1.000)*	-0.243 (-3.297, 1.002)***	-0.149 (-1.673, 1.000)†	-0.167 (-2.067, 1.002)*
Independent variable						
GSCM		0.467 (5.861, 1.002)***		0.532 (7.203, 1.002)***		0.417 (5.158, 1.002)***
R^2	0.002	0.220	0.048	0.331	0.022	0.196
R^2 *change*	0.002	0.218	0.048	0.282	0.022	0.174
F-value	0.236	17.326***	6.284*	30.363***	2.797†	14.991***
F change	0.236	34.352***	6.284*	51.877***	2.797†	26.607***

Note: *** $p < 0.001$; * $p < 0.05$; † $p < 0.10$.

The numbers in parentheses are: [a] *t values and* [b] *variance inflation factor (VIF).*

Table 5b: Effect of GSCM on performance: regression results

	Environmental performance		Operational performance		Financial performance	
	Step 1	Step 2	Step 1	Step 2	Step 1	Step 2
Control variable						
Firm size	0.044 (0.486[a], 1.000[b])	0.019 (0.231, 1.026)	-0.220 (-2.507, 1.000)*	-0.247 (-3.270, 1.026)***	-0.149 (-1.673, 1.000)†	-0.146 (-1.801, 1.026)†
Independent variables						
GSCM1		-0.017 (-0.171, 1.471)		0.131 (1.450, 1.471)		0.082 (0.844, 1.471)
GSCM2		0.076 (0.757, 1.593)		0.084 (0.897, 1.593)		-0.123 (-1.212, 1.593)
GSCM3		0.027 (0.264, 1.709)		-0.011 (-0.117, 1.709)		0.116 (1.106, 1.709)
GSCM4		0.279 (2.929, 1.431)**		0.030 (0.339, 1.431)		-0.010 (-0.103, 1.431)
GSCM5		0.185 (1.643, 2.013)		0.193 (1.820, 2.013)†		0.256 (2.252, 2.013)*
GSCM6		0.053 (0.433, 2.371)		0.148 (1.285, 2.371)		-0.040 (-0.324, 2.371)
GSCM7		0.044 (0.366, 2.239)		0.133 (1.195, 2.239)		0.250 (2.081, 2.239)*
R^2	0.002	0.260	0.048	0.350	0.022	0.247
R^2 *change*	0.002	0.258	0.048	0.302	0.022	0.225
F-value	0.236	5.140***	6.284*	7.874***	2.797†	4.807***
F change	0.236	5.831***	6.284*	7.758***	2.797†	5.003***

Note: *** $p < 0.001$; ** $p < 0.01$; * $p < 0.05$; † $p < 0.10$.

The numbers in parentheses are: [a] *t values and* [b] *variance inflation factor (VIF).*

GSCM1: Cross-functional cooperation for environmental improvements; GSCM2: Require suppliers to use environmental packaging (degradable and non-hazardous); GSCM3: Making joint decisions with supplies about ways to reduce overall environmental impact of our products; GSCM4: Cooperation with customers for eco-design; GSCM5: Developing a mutual understanding of responsibilities regarding environmental performance with customers; GSCM6: Working together with customers to reduce environmental impact of our activities; GSCM7: Making joint decisions with customers about ways to reduce overall environmental impact of our products.

Table 6: Correlations between measurement items of GSCM

Measurement items of GSCM	Mean	S.D.	1	2	3	4	5	6	7
1. GSCM1	3.849	0.811	1.000						
2. GSCM2	3.905	0.959	0.352**	1.000					
3. GSCM3	3.746	0.876	0.351**	0.524**	1.000				
4. GSCM4	3.627	0.936	0.337**	0.299**	0.293**	1.000			
5. GSCM5	3.881	0.845	0.476**	0.440**	0.435**	0.480**	1.000		
6. GSCM6	3.984	0.829	0.508**	0.350**	0.490**	0.466**	0.625**	1.000	
7. GSCM7	3.841	0.843	0.421**	0.466**	0.541**	0.462**	0.569**	0.660**	1.000

Note: ** $p < 0.01$ *(2-tailed).*

Figure 1: Theoretical model